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THE LEGACY OF OAK RIDGE:

AN UNCLASSIFIED BRIEFING

Waste Migrates While Inspectors Quibble

by

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Director

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PREFACE

Recent publicity about illegal dumping of hazardous wastes in the State of Tennessee has brought renewed interest in the regulation and clean-up of hazardous waste sites. Attention has especially focused on the Oak Ridge atomic industry, which for four decades has produced chemical and nuclear wastes in prodigious volume, but has claimed exemption from both state and federal regulations for reasons of national security and nuclear preemption.

A recent unanimous decision by the United States Supreme Court in Pacific Gas and Electric, et al. v. State Energy Resources Conservation and Development Commission, et al. has cleared the way for the State of Tennessee to enforce its own standards if federal regulatory agencies continue at their present impasse.

This report is addressed to the people of Tennessee, whose concern must be for a safe and healthy environment for future Tennesseans. It is the purpose of this report to examine the extent of whatever environmental hazard may be posed by the waste sites at Oak Ridge and to suggest some steps which should be taken to protect the public health.

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CHAPTER 1

INTRODUCTION

There is a place within the territory of the United States of America where the feathers of sparrows set geiger counters clicking at 26,000 counts per minute, where each gram of soil over several acres contains over 50 picocuries of plutonium, and where for the last 40 years the creek and lake waters have exceeded state and federal regulations for allowable radioactive pollution. This place is not on the grassy plains around Rocky Flats, on the tumbleweed desert of the Nevada Test Site, or on the South Pacific island of Bikini, but in the rolling hills and forests of Tennessee. This contamination of nature and its inhabitants is found near Oak Ridge, birthplace of the atomic bomb and for four decades a nuclear power laboratory and weapons factory.

Recently Tennesseans have become concerned about the hazards of waste migration from toxic chemical landfills and about what the future holds for rusting drums full of lethal poisons which are almost daily being found in remote pastures and wooded hollows. In 1983, the General Assembly considered bills to make toxic waste dumping a felony [1], to require industries to get licenses for hazardous waste sites [2], to establish a responsible waste disposal fund [3], and an abandoned site clean-up superfund [4]. The legislature also considered legislation to assume greater State jurisdiction under the Safe Drinking Water Act [5] and the Resource Conservation and Recovery Act [6]. Yet one of the most hazardous dump sites in the State has for many years lingered just beyond the borders of legal jurisdiction, at the Oak Ridge federal reservation.

Now a ruling by the United States Supreme Court may have changed the situation. It opens the prospect for state regulation, and even prohibition, of federal nuclear activities at Oak Ridge unless greater care is taken in disposing of the nuclear wastes being generated.[7] From the standpoint of some state administrators, state regulation is less preferable to federal regulation of nuclear activities. But even reluctant administrators may admit that the threat of state regulation might be what is needed to force federal agencies to act.

This report will serve as a background paper on the subject of nuclear pollution from Oak Ridge. It is not intended as a comprehensive, or final study of the entire physical, medical and legal dilemma at Oak Ridge. Hopefully it will serve to inspire those with authority to take action to do so, now, and quickly. As this report will document, the potential human tragedy grows deeper, and more inexorable, with each passing day.

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CHAPTER 2

RADIATION AND HUMAN HEALTH

Radiation is literally the emanation of anything from a source point. It is the light leaving a star, or an electric lightbulb. It is the sound leaving the instruments of a string quartet, or the sparks from a sparkler on the Fourth of July. It is also the emanations produced by the spontaneous disintegration of unstable, radioactive elements. The radiation from these sources is both particulate and waveform. It is tiny microscopic bullets and beams of energy that penetrate between the spaces of molecules in any nearby material until they are either captured by an atom--which may then become radioactive itself--or bounced about until their energy is spent.

Radiation is of biological concern because the amount of energy contained in a single high-speed particle or ray may be sufficient to disrupt or ionize the molecules of living tissue. In biological systems, reactions are carefully controlled, often by special geometric juxtaposition of the reactants. A marauding high-speed electron does not regard this careful juxtapostion and will randomly destroy whatever order it encounters, sometimes generating lengthy chain reactions which expand the otherwise small area of influence. Radiation increases the entropy, or disorganization, of biological systems.[8]

In the human cell, certain chemical bonds are crucial to the integrity of the genetic code, and breaking just a few of these normally very strong bonds may cause a mutation. When a mutated chromosome is responsible for regulating cell growth, an uncontrolled proliferation of damaged cells, or "cancer", can develop. When a mutation occurs in the procreative cells or in the developing embryo, birth defects can result. When mutations occur in the blood-forming tissue, impairment of the immune system can result, and this can give rise to an entire spectrum of human disease. Radiation is therefore said to be mutagenic (cell-mutating), oncogenic (tumor-forming), carcinogenic (cancer-causing), teratogenic (birth-defect causing), and immuno-suppressing (lowering resistance to disease).

These effects, which occur at a microscopic, cellular level, may take a long time to reach observable proportions. Since there are billions of cells in each gram of tissue and because some tissues regenerate very slowly, the latent effects of radiation may not become capable of diagnosis for more than 50 years after the exposure. Because chronic radiation diseases are identical in etiology to a vast number of other, non-radiation-induced diseases, absolute proof of causality is a physical impossibility in most individual cases. Some 943 dominant and 783 recessive diseases are recognized as caused by radiation-induced mutations in the newborn. According to the National Academy of Sciences, "the spectrum of radiation caused genetic disease is almost as wide as the spectrum from all other causes." Moreover, the genetic commitment from radiation tends to be cumulative, resulting in increased susceptibility to environmental injury in future generations, and is only eliminated by gene extinctions--the genetic deaths or non-reproductive lives of individuals who carry the mutations.[9]

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CHAPTER 3

THE WAR COMES TO TENNESSEE

3.1 The Discoveries in Germany

As early as the turn of the Nineteenth Century scientists recognized that it was theoretically possible to fission, or split apart, very dense elements like uranium and create two lighter elements. Albert Einstein had theorized that atom splitting could liberate enormous amounts of binding energy--the force that held the atoms together. The actual fissioning of uranium was first demonstrated by Otto Hahn and Fritz Strassman in the Berlin laboratories of Kaiser Wilhelm Institute in the fall of 1938. These scientists communicated their discovery to Lise Meitner, a Jewish co-worker who had fled Nazi Germany for Niels Bohr's laboratory in Copenhagen. Meitner analyzed the energy of the reaction using Einstein's 1905 formula, E = mc2, and discovered that 200 million electron-volts were released for each atom fissioned. Bohr then crossed the Atlantic and conveyed the news to Einstein, Enrico Fermi and others. At the urging of these atomic scientists, President Franklin D. Roosevelt ordered the secret formation of an atomic bomb project and assigned it the highest and most secretive military priority. The code name for the project was the Manhattan Engineering District.

3.2 The Manhattan Project

3.2.1 Clinton Engineer Works

The project sought to locate its key research facilities in isolated areas that had access to large amounts of electricity. The first of these facilities was located near the village of Clinton just below the Norris Dam in rural Tennessee. It was called the Clinton Engineer Works. Clinton's initial function was to perform research pertaining to the atomic pile project located at Enrico Fermi's metallurgical laboratory in Chicago. After Fermi's initial chain reaction in 1942, Clinton became an enriched uranium and plutonium production facility, a pilot plant for the Hanford Engineer Works in Washington, and a vast experimental laboratory.

The tract of land comprising the Clinton Works, within whose boundaries the gas and thermal diffusion plants (K-25 and S-50), the electromagnetic plant (Y-12), the ORNL laboratory (X-10) [10], the Clinton pile plants, and the town of Oak Ridge (pop.: 29,000) were constructed, consists of approximately 38,000 acres located in Roane and Anderson Counties. The land was acquired under the forced condemnation procedures of the War Powers Act, giving immediate possession of the land to the United States and removing several thousand rural families.[11]

3.2.2 The Clinton Pile

Once the atomic pile experiment in Chicago had achieved a critical reaction of uranium, on December 2, 1942, a production reactor was needed to produce a small quantity of plutonium for criticality experiments. To accomplish this, a graphite reactor was constructed at Oak Ridge.

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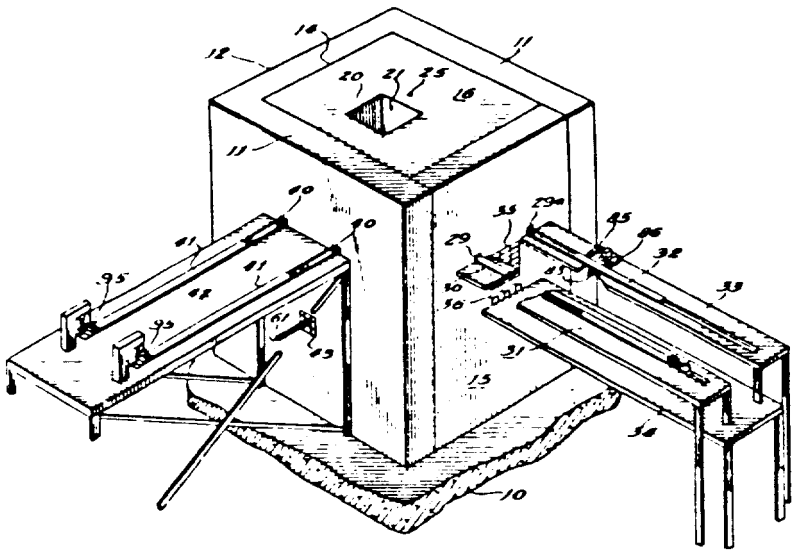
Figure 1. An Early Reactor



Patent No. 2,708,656 was issued on May 18, 1955 to Enrico Fermi and Leo Szilard. The invention it covers includes the first nuclear reactor, Chicago Pile No. 1 (CP-1). Although the patent was applied for in December 1944, it could not be issued until years later when the secret was declassified. This drawing was in the patent application.

The 1000-kilowatt, air-cooled, uranium-graphite pile at Clinton consisted of a 24-foot cube of graphite surrounded by laminated concrete and perforated with 1260 metal channels. Through the channels uranium slugs were forced. After the slugs were irradiated to generate plutonium (by the capture of free neutrons), the hot slugs were forced out at the rear face, falling onto a mattress pad, and dumped into a bucket of water in a discharge pit. Full buckets were then moved along a trench to the separation building.[12]

By November 4, 1943, the Clinton pile was operating at 500 kilowatts. While small by today's standards--one thousandth of the size of a TVA nuclear reactor--the Clinton pile was a very "dirty" reactor. In modern reactors, the radioactive pollutants produced by the fission of uranium are trapped inside zirconium fuel rod cladding until the fuel is replaced every three years. Thereafter, the cladding is kept intact in spent fuel pools until the rods are transfered to a federal waste repository, where this cladding is kept intact for millenia. In the normal life of a fuel rod, small cracks may develop which release about 1 percent of the fission products to the coolant, either in the reactor vessel or in the storage pool. Within a pressurized water reactor, the coolant is filtered with resin bead demineralizers, and these resins are then placed in waste storage. The amount of fission products escaping to the environment after demineralization and other filters have done their work is

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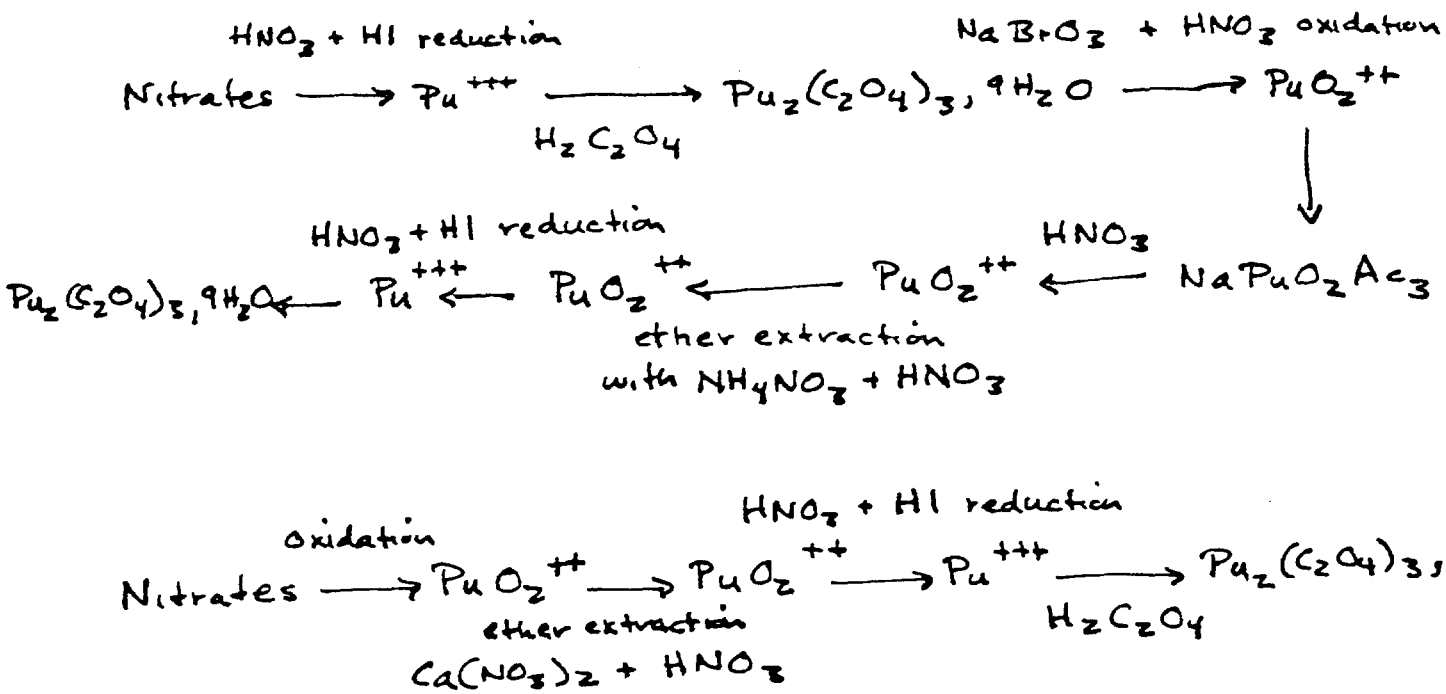
very small--a fraction of a percent. Still, the Nuclear Regulatory Commission estimates that normal, filtered releases of radiation from the current U.S. fuel cycle will cause some 652 lethal cancers and 1,155 genetic defects among the people who live downwind or downstream.[13]

At the Clinton pile, all of the lethal fission products were ducted to a stack and vented directly to the atmosphere. Installation of large fans to increase air-cooling permitted power levels of 4 megawatts by late 1944. After the war, the pile was shut down and disassembled. To the present time, there have been at least nine reactors in operation at Oak Ridge, of varying size and complexity, plus a continuing series of critical assemblies in the test facilities.

Another objective of the Clinton Laboratory was to develop a workable process for separating plutonium from uranium and other fission products. The first batch of slugs was received at the processing stage on December 20, 1943. Based upon information gathered in processing experiments on the first 37 batches, an isolation method employing a precipitation, solution, and reprecipitation of plutonium peroxide was developed. (See Figure 3.) Alternative processes were also explored until finally a bismuth phosphate process was adopted for Hanford, where a large plutonium production facility was under construction. In all, 299 batches of slugs were processed in the separation building during the war, with an overall yield of 90.5 percent of the available plutonium.

Figure 2: Separation Processes



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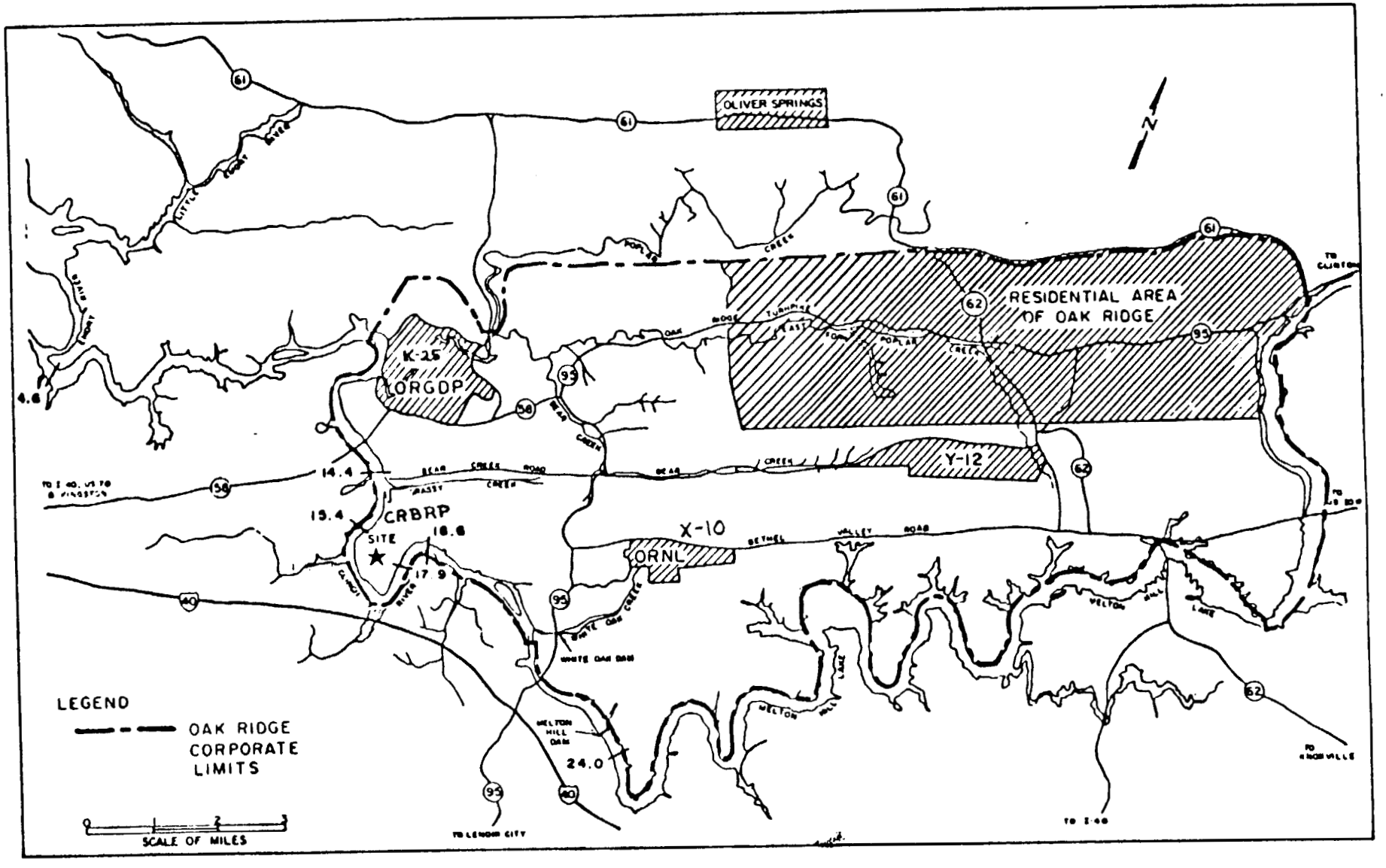
OLIVER SPRINGS
RESIDENTIAL AREA OF OAK RIDGE
K-25
ORGDP
Y-12
X-10
ORNL
CRBRP
SITE
4.6
14.4
15.4
16.6
17.9
24.0
WHITE OAK DAM
WELTON HILL DAM
LEGEND
OAK RIDGE CORPORATE LIMITS
SCALE OF MILES
TO LENOIR CITY
TO I-40

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3.2.3 S-50

Pure U-235-enriched uranium was needed by the project for actual weapon material and for improved plutonium production reactors. U-235 is a fissionable isotope suitable for bombs, but U-235 occurs in only trace amounts in nature. In uranium ore, U-238 is typically 139 times more abundant than U-235. The S-50 and K-25 plants, and parts of Y-12, were built to separate "Tweedledee" (U-235) from "Tweedledum" (U-238).

In the S-50 liquid process, thermal diffusion was used to draw Tweedledee to the hotter of two surfaces while convection was employed to carry it upward, developing a vertical concentration gradient. The sole uranium-containing substance which could be used for this process was uranium hexafluoride, UF-6. Since fluorine is a very unmanageable element--igniting even asbestos and corroding practically anything--it had never been manufactured on an industrial scale. Using private industry and military appropriations priorities, the Manhattan project built a fluorine production facility in a few months. To obtain UF-6, uranium tetrafluoride had to be prepared by a wet chemical method and fluorinated at 350°C. Then, to keep the UF-6 fluid, all parts of the process had to be kept above 155°F and under 1500 pounds of pressure. The corrosive nature of UF-6 made it necessary to use pure nickel for all process lines.

A pilot plant was first constructed in Philadelphia to process UF-6 by liquid diffusion. However a disasterous explosion in this plant in August, 1944, forced the operation to hastily switch to Oak Ridge, where S-50 went into operation on September 10th. Early processing was hampered by construction work still in progress and by lack of experienced operators (many of whom had been killed in the Philadelphia explosion). Large scale production was not achieved until January, 1945. In September, it was determined that the radiation separation process at Y-12 and gaseous diffusion at K-25 were more efficient and S-50 was closed.

3.2.4 K-25

The K-25 plant separates Tweedledee from Tweedledum by the method of separation known as gaseous diffusion. According to Graham's law, the rates of diffusion for different gases through a porous material are inversely proportional to the square roots of their molecular weights. Again the only form of uranium that could be used for this process turned out to be uranium hexafluoride. Moreover, since the mean free path of UF-6 molecules is exceedingly small, the porous membrane--which has to be capable of withstanding the chemical corrosivity of UF-6--must be made with pores of less than one-millionth of an inch. To reach significant concentrations of Tweedledee, or "Tuballoy," the UF-6 has to be passed through millions of such membranes, shaped as tubes. The enrichment plant built during the war enclosed a total of 6,578,000 tubes, having a total length of 8653 miles, or three times the distance across the Atlantic Ocean. The K-25 building itself covered over 152 acres. With additional buildings in the enrichment facility included, over 600 acres were under roof. The amount of electric power needed to drive the

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compressors and heat and cool the processes was equivalent to that consumed by the continent of Australia.

According to an employee who worked in the Union Carbide gaseous diffusion plant in Paducah, Kentucky, the Department of Energy (DOE) never enforced minimal standards of radiological safety on Union Carbide. The radioactive gases in the plant were "so thick you could see the haze in the air when you looked at the ceiling light, and you could taste it coated on your teeth and in your throat and lungs. After a couple of hours of work the uranium dust on the floor was so thick you could see your tracks when walking around." According to the worker, Union Carbide routinely recalibrated its geiger counters to zero inside "hot" rooms, rather than outside, and if high readings were encountered on the production lines, the worker taking the reading would be told to go back and check again "until he got it right."

3.2.5 Y-12

Y-12 was built in 1943 to separate uranium by an electromagnetic, radiation process. This separation work was discontinued in 1947 in favor of the K-25 process. Since the war, Y-12's mission has been to fabricate and certify the critical components of hydrogen bombs. To accomplish this, Y-12 performs chemical processing, metal forming, precision plating and coating, powder metallurgy, joining, precision machining, and filiment winding.

UF-6 arrives in pure metal blocks from Fernald, Ohio and is fed like cordwood into a giant rolling press which flattens the metal into sheets five-and-a-half feet wide and one-inch thick. Smaller presses then roll the sheets until they are only five-thousandths of an inch thick. The foil is cut by a giant "cookie-cutter" into the shapes needed to form spheres. So precise is the final joining and machining that special chemical adhesives must be applied to keep the foil from changing shape under its own weight. The purpose of these foil spheres is to serve as a radiation mirror; to hold the nuclear reaction within the H-bomb for the one-millionth of a second that it will take to ignite the fusion fuel completely.

The diagram on the following page (Figure 3) shows how the H-bomb is constructed. The decision to include the drawing in this report was difficult, because doing so increases the risk of nuclear proliferation. The decision was made to include the drawing for two reasons. Firstly, all of the information was obtained from the open literature which can be read in almost any library or bookstore in the United States. Secondly, and more importantly, the Department of Energy and Union Carbide overuse the mystique of secrecy to cover-up wrongful, negligent conduct. The processes involved are not difficult to understand and the quantities of process materials, like the number of weapons themselves, are no longer kept secret from any potential enemy. Indeed, the posture of the United States in arms control negotiations is, and must be, disclosure of weapons and weapons-production capabilities in order to achieve first, parity, and later, reductions.

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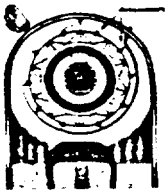
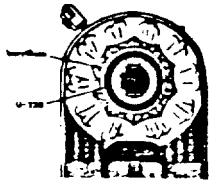
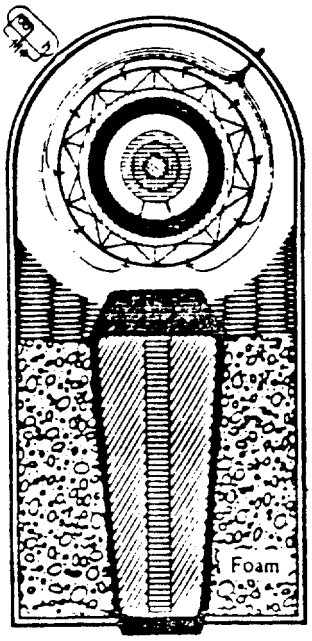
(from Morland, H.)



Monsanto makes the electrically fired detonators surrounding the primary . . .



which set off the chemical high-explosive charges, made by Mason and Hanger–Silas Mason, that surround a hollow spherical tamper made of beryllium and uranium-238. The tamper, manufactured by Union Carbide, is liquefied by the implosive shock wave and driven inward toward the softball-sized fissionable core of the primary.



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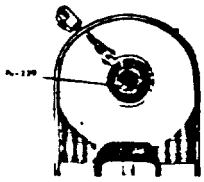
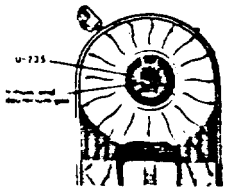
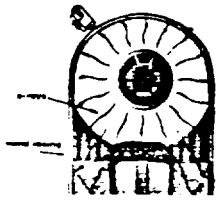


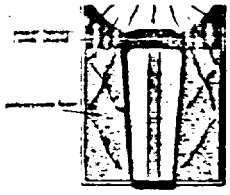
The core is compressed to supercriticality by the tamper, and a beam of high energy neutrons is fired from outside the casing by a high-voltage vacuum tube made by General Electric. The neutrons start a fission chain reaction in the plutonium-239 "pit" made by Rockwell.



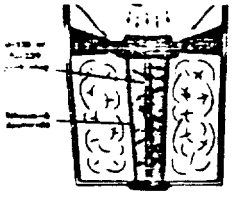
The chain reaction spreads to a layer of uranium-235 surrounding the pit, and the heat and pressure of fission ignite a hydrogen fusion reaction in the "booster" charge of tritium and deuterium gas, supplied by Du Pont. Fusion adds neutrons to the fission reaction, speeding it up and raising its temperature.



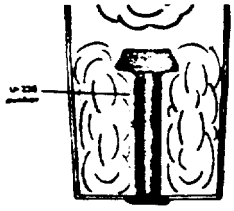
The energy of the fission reaction races away from the primary in the form of x-rays which are momentarily trapped by the bomb's metal casing . . .



focused through a paper honeycomb shield, and absorbed by a special polystyrene foam "channel filler" made by Bendix, which serves as a thermal explosive encasing the secondary.



The exploding styrofoam compresses the secondary, which is filled with lithium-6 deuteride. A "spark plug" of uranium-235 or plutonium-239, running down its center, is compressed to supercriticality, and a second fission chain reaction thus begins to supply neutrons which convert lithium-6 into tritium.



The nuclear explosion of the spark plug generates the temperatures and pressures needed to fuse the newly created tritium with deuterium, showering the casing of the secondary with high-energy neutrons created by fusion. The neutrons cause uranium-238 in the casing of the secondary (called the "pusher") to undergo fission. The lithium and uranium parts are made by Union Carbide.

The fission of uranium-238 supplies most of the energy that allows an explosive device the size of a kitchen garbage can to destroy an entire city, along with its outlying suburbs.

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3.2.5.1 How an H-Bomb Functions

Here is how a nuclear weapon works. In the simple atomic bomb, a subcritical mass of a fissionable element such as plutonium is brought to sudden criticality. In small quantities, fissionable elements give off stray neutrons which are lost to the surroundings. Compacted into a "critical mass," however, the neutrons serve to split the atoms, or fission, the host element. In changing the atomic weight of the element, a certain portion of the previous weight is converted to energy.

In order to bring about sudden criticality, a subcritical mass is surrounded by a shaped charge of conventional explosives, and when the explosives are detonated, the mass implodes, becoming critical. In the rapid fission of billions of atoms, the binding magnetism that held the first element together is suddenly emanated as energy--the explosive force of the bomb.

A hydrogen bomb uses one or more later stages to amplify the power of the atomic bomb. The radiation and heat of the atomic explosion are used to join lighter elements together, or fuse them, into heavier elements. Again, with the change in atomic weight of the elements, binding energy is released. The effect is a thermonuclear explosion.

Hydrogen is the lightest element in nature, having one proton, one neutron, and one electron. For nuclear weapons, the heavy isotopes of hydrogen, deuterium (with two electrons) and tritium (with three electrons) are used to provide the fuel for the fusion reaction. Not infrequently, one or more later stages are also added, so that the radiation of the first two reactions (fission and fusion) triggers a fission reaction in one or more outer casings. The uranium spheres made at Oak Ridge, for instance, serve to reflect the radiation of the plutonium trigger just long enough to uniformly ignite the fuel, and then the reflectors are themselves fissioned in a third stage reaction.

During World War II, Edward Teller first initiated work on the hydrogen bomb, which he called "the super." After the war, President Harry Truman made the decision, against the advice of his atomic weapons advisory board (which wanted to negotiate an immediate ban on H-bomb research with the Soviet Union) to rush into development of thermonuclear weapons. Teller's device was successfully exploded, but it was really a ruse designed to scare the Soviets and not a weapon capable of delivery to an enemy country. Teller's device was fueled with tritium gas and weighed more than 75 tons. The tritium gas was unstable and so a precise configuration of the device's contents was only possible for a short period of time. The first H-bomb was a device, not a weapon.

It was the Soviet Union that first devised a practical thermonuclear weapon, using a theory first published by a German scientist, Hans Thirring, in 1946. American scientists were alerted to the Soviet discovery by global fallout from the Soviet tests. The fallout was found to contain lithium-6, a rare isotope of the third lightest element in the atomic table. Lithium-6 is

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of similar construction to two atoms of tritium or three atoms of deuterium but it is more stable, and can be combined with a deuterium-oxygen molecule to form a chalky powder called lithium-6 deuteride.

Lithium-6 deuteride is the form of fusion fuel used in most U.S. weapons today. In some weapons, tritium is also injected from a high pressure tank as part of the final arming sequence. At Y-12, deuterium shipped from the Savannah River Plant is bonded with the lithium-6, pressed into tablets and baked in an isostatic pressure vessel (at 30,000 psi and 300°F.) and then machined to final dimensions. Since this ceramic material decomposes from moisture, it is handled in closed dry cells, where it is assembled into a tapered column about two feet high.[14] Both the finished uranium mirrors and hydrogen fuel are shipped to the Pantex Plant near Amarillo, Texas for final assembly into nuclear weapons.

3.2.6 X-10

Of the 16,000 Department of Energy employees at Oak Ridge, about 5,000 work at the Oak Ridge National Laboratory (ORNL or X-10). The ORNL complex comprises some 192 buildings with more than 2.6 million square feet under roof. It includes an isotope separation facility, a high-flux test reactor, an electron linear accellerator, a transuranic waste processing plant, a research reactor, an isochronous cyclotron, a high-level radiochemical lab, a materials processing lab, a thorium-uranium fuel reprocessing facility (the Shippingport breeder operated by the Navy runs on thorium fuel which is recycled to produce fissionable U-233), a high-level radiation examination lab, an environmental sciences lab, a heavy-ion research facility, and a superconducting magnet (fusion) test facility.

While not all of the processes at ORNL are declassified, it is likely that many of them produce equal or greater volumes of liquid discharge than the processes at Y-12. In particular, the spent-fuel reprocessing plant deals with an entire spectrum of liquid and gaseous fission products which are highly radioactive. The discharges from X-10 bear further investigation.

CHAPTER 4

THE PROBLEM: WASTE MANAGEMENT AT OAK RIDGE

4.1 The Old Days

During the war, the waste byproducts of the new experimental military processes, like most industrial waste streams of that era, were of little concern. The quantities of waste being generated were relatively small and were simply flushed into the nearest stream, along with the sewage and greywater. The solution to pollution was dilution. As the experimental processes went into actual production, highly radioactive wastes were stored in steel tanks, in part because they were thought to have potential value. During the first years of Oak Ridge two distinct and conflicting philosophies of waste management emerged: (1) dilute and forget, and (2) concentrate and keep forever. While the second philosophy has intrinsic problems of its own, this report will confine its discussion only to the former, more dangerous approach. Some of the same radioactive wastes that were concentrated and stored in the 1940s and 1950s because they were considered too dangerous to release, are now planned for dilution and release--by hydrofracture injection--in 1983 and 1984.

As the theoretical work carried on by the physicists at the University of Chicago and at Los Alamos turned into actual demonstration and full scale weapons production, the demands on Oak Ridge to produce larger quantities of enriched uranium and pure plutonium increased. In the rush to beat Nazi Germany to the atomic punch, virtually no concern was given to the back-end of the Oak Ridge processes, or to the long-term ecological effects that those radioactive discharges might have.

Still, to reduce the recognized biogenetic impact of released transuranic fission products--the isotopes with the shortest half-lives and greatest potential effect--"settling" ponds were erected in 1944. Later these ponds were renamed as "retention" areas, because the water did not remain in them long enough to permit significant settling of suspended solids.

4.2 The Radwaste Retention Ponds

The largest retention area was behind a 90-meter earthen dam just above the White Oak Lake impoundment. White Oak Lake was a 7 million cubic-foot reservoir entirely within the Clinton security perimeter. The outflow of the lake runs into and mixes with the waters of the Clinch River about one-quarter mile below the overflow at lower White Oak Lake dam.

Having no frames of reference upon which to set discharge limits, the Oak Ridge scientists established a limit of 100 mrem/day for aquatic organisms below the White Oak Lake dam, about 1500 times the EPA allowed limits of today. At the time they were severely criticized and ridiculed for ultraconservatism.[15] Yet because of these lax standards, between 1944 and 1962 at least 12,000 curies (450,000,000,000,000 disintegrations per second) of radioactive isotopes were discharged to the Clinch River.[16]

Many of the old Tennessee moonshiners displaced by Oak Ridge probably knew more about the behavior of creeks and winter surface runoff than did the highly

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paid scientists and engineers who came after them. In the winter of 1944, the 90-meter dam on the main holding pond washed out, inundating the White Oak Lake floodplain with plutonium, americium, uranium, cobalt, and hundreds of other isotopes.

Table-1. Range in concentrations of actinides in boxelder tree leaves, median soil concentrations, and calculated minimum and maximum concentration ratios on the White Oak Creek floodplain.

Statistic	^{239}Pu	^{241}Am	^{234}U	^{238}U	^{244}Cm
Concentration range in leaves (fCi/dry g)	< 0.5 to 32.0	1.4 to 13.5	5.4 to 45.9	1.8 to 33.8	0.9 to 9.0
Median concentration in soil (fCi/dry g)	61460	28090	4325	2590	541
CR minimum (x 10^{-3})	0.008	0.050	1.25	0.70	1.66
CR maximum (x 10^{-3})	0.52	0.48	10.6	13.1	16.6

*CR = leaf concentration/median soil concentration.

4.3 Forest and Stream Ecology

In 1958, the radiation level of the dry lakebed was 10 to 50 mR/hour at a level of 1 meter above the ground.[17] Song sparrows, field sparrows, and water thrushes collected at that time showed feather radiation levels of greater than 400 counts per second per gram (cps/g) and bone concentrations of 200 counts per second per gram.[18]

In 1978, plutonium alone still measured more than 100 picocuries per gram of soil (100 pCi/g: 4 alpha counts per second per gram at surface) along the creek banks, at the former dam, and at the floodplain's north end where the creek emptied into the old retention pond. The integrated concentration of plutonium-239 in floodplain soil was 65 pCi/g (1.9 cps/g).[19] Nationwide, the average for naturally occuring radiation in soil is about 3 pCi/g (about 1 pCi each of Ra-226, Th-232, and U-238). Plutonium does not exist in nature, but is a man-made element. It is so toxic that the smallest amounts capable of injection into the blood of laboratory mice and beagles induces fatal cancer. One twentieth of an ounce of plutonium is theoretically sufficient to kill every person on Earth.[20]

Oak Ridge scientists now get federal grants to study how much plutonium, cesium, cobalt and other heavy elements are taken up through the roots of plants and trees and exhaled through their leaves with the dew. (See Table 1.) Scientists are also studying the concentrations of these elements on insects, fish, and small animals. There was found to be a significant ($P<0.01$) positive correlation between concentrations of radiocesium and plutonium in biota from the floodplain, consistant with the relationship of cesium to plutonium

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concentrations in tissue observed near the Los Alamos site in New Mexico.

The studies on other species point to many unanswered questions, troublesome issues, and ethical problems of our relationship to other species. It was found that the common redworm had been exposed to an average dose rate of 230,000 mrad per year for about 150 generations, and had developed new chromosomal abberations--genetic drift--as a result. (See Table 2.) It was found that the pipe-organ and mud-dauber wasps seemed to prefer to build their nests of radioactive lake mud while the black-and-yellow mud-dauber wasps seem to carefully avoid this mud. It was also learned at Oak Ridge that while honey bees can individually survive high radiation fields, smaller doses completely destroy the highly organized social environment of the hive.[21]

Table-2. Chromosome Aberrations in Irradiated and Nonirradiated Natural Populations of Redworms (Chironomus tentans).

	Irradiated populations	Nonirradiated populations
Larvae analyzed	692	714
Number of different inversions* found in both populations	6	6
Number of different inversions* unique to one population	10	0
Number of deletions unique to one population	1	0

Recently Oak Ridge scientists discovered that fish may react to the stress of a radioactive environment or body-burden by producing more offspring.[22] While the effect, if proven, may serve to compensate a species and prevent extinction, imbalances of this type may also lead to an artificial dominance of particular species within an econiche. A chain of further imbalances may result from that unnatural dominance, including secondary species extinction.

4.4 The Trench Sites

The end of the War brought a number of changes in the management of Oak Ridge, but it did not alleviate the pressures of production quotas. All through the 1950s, the United States was engaged in a race with the Soviet Union to build enough nuclear weapons to deter an attack by the other. The more weapons either side acquired, the higher the level of weapons each felt would be necessary for effective deterence. In this atmosphere of competition for survival, waste management again took a back seat.

Between 1951 and 1965, about 40 million gallons of radwastes were slurried into long earthen trenches at Oak Ridge sites. Underlying the trenches was a deep strata of Conasauga shale. The AEC engineers believed that if and when

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hot slurry escaped the trenches, it would be absorbed by the porous rock and radioactive elements would bond with the shale. There it was hoped they would remain confined, safely bonded in rock, for thousands of years.[23]

The Tennesseans who had had their outhouses bulldozed by the Corps of Engineers probably would have known better. Groundwater washed through the trenches every time it rained. At Oak Ridge the mean annual rainfall is 125 cm. With this perennial flow, the radioactive elements soon left the trenches and found their way into surrounding soil, into the tributaries of the Clinch River, and off the Oak Ridge reservation.

So bad did one "cobalt seep" become that outside scientists were called in by the AEC to study the problem. They found that Burial Trench No. 7 was contaminating a spring that ran directly into White Oak Creek. The study group found not only elevated levels of uranium, plutonium, curium, thorium, and radium in the spring, but dangerous levels of mercury and PCBs.[24]

Oak Ridge managers now say that the total sum of radioactivity released to the river amounts to less than 7 curies per year. This is not to say that the total released into the environment is this amount. The Clinch River is still a long ways from the several points of discharge now leaking. How much is in the ground, and groundwater, is indeterminate. How much is being added daily is undisclosed.

4.5 River Ecology

Louis G. Williams, a biologist and professor emeritus of ecology at the University of Alabama in Tuscaloosa, has for several years measured the uptake of radionuclides by plankton and other aquatic organisms in the food web of the Tennessee River which flows south from its confluence with the Clinch and into Alabama. In 1978, when Hurricane David soaked the Oak Ridge burial grounds, Williams measured a "slug" of radioactive material traveling down the river by measuring its concentrations in the food web. "I found concentrations of cobalt that were 6,000 times higher than background, and concentrations of strontium and cesium 8,000 to 10,000 times higher," he reported.[25]

At the present time state radiological safety inspectors are not routinely permitted to inspect Oak Ridge discharge points into Tennessee creeks and streams. Usually a state inspector will drive to Gallaher bridge over the Clinch River a mile below the Bear Creek outlet, several miles from the Y-12 and X-10 plants, and drop a "grab-bag" in for a monthly sample of river water at midstream. Then the inspector will walk a little farther downstream and take a second sample at Clinch River mile 10, some distance below the Poplar Creek outlet near K-25. These two sampling points form the State's best guess for what is being discharged.

4.6 Tritium

Tritium, or H-3, is discharged by both X-10 and Y-12. The human body regards tritium, which usually comes to it in the form of tritiated water

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molecules, as no more harmful than water. The basic building blocks of life, including our DNA and RNA, cannot distinguish between a hydrogen atom that has one electron and hydrogen that has two or three electrons. It is simply assimilated into the cellular or genetic material.

Tritium is a deadly isotope. Six milligrams ingested into the body will cause death within 48 hours. Because it has a shorter halflife than plutonium, it delivers nearly 200 times more radiation per gram.[26]

Normally the tritium found in river water is below the limits of detection (about 100 pCi/l for state laboratories). But not infrequently, the river water sampled at both Gallaher bridge and Clinch mile 10 contains measurable amounts of tritium. In June, 1981, 2,743 pCi/l of tritium was recorded from the monthly grab-bag at Gallaher and 23,241 pCi/l (2.34 x 10E-12 grams) from mile 10. Since the limit allowed by the NRC for off-site water samples is 3 million pCi/l [27], the tritium was within the federal and state limits after being diluted with several million parts of river water.

Given that soft-drink bottlers and municipal water supplies are downstream, and given also that tritium is but one of hundreds of radionuclides discharged by Oak Ridge, the risks become serious indeed. It wouldn't matter that public water was chlorinated or filtered first, because that would have no effect on tritium, which is molecularly bonded to the water. By the time the tritium reaches the end-users, it is very dilute, but it is still present.[28] The public health impact is there, it just may not be capable of immediate detection.

4.7 New Hope Pond and East Fork Poplar Creek

There are perhaps 100 separate discharge pipes coming from the production plants at Y-12. [29] These pipes drain into the "industrial ditch" which is the aboveground trench leading down Chestnut Ridge, past the coal pile at the New Hope steam plant, and into New Hope Pond. The untreated discharges include rinse water from the metal plating shop, lab drains, mop water, laundry water, liquid coolants, and trace amounts of mercury. New Hope Pond was built in 1963 to dilute the discharge before it leaves federal property and enters the East Fork Poplar Creek. Approximately 6 million gallons of water are added each day to insure that dilution is adequate.

Downstream, in the East Fork Poplar Creek, there is no aquatic life. Studies show high levels of mercury, uranium, thorium and PCBs in the creek sediments. Plant life growing beside the creek in December, 1981, was found to have the highest concentrations of mercury in any material ever analyzed by the U.S. Geological Survey. The Geological Survey researchers who reported their findings in February, 1982, were charging official "cover-up" by May 21, 1983.

The mercury is part of a secretive process used at Y-12 to separate lithium-6 from natural lithium. The separation process used is one pioneered by James A. McLaren at Edinborough, Scotland in 1931. It involves an electrolytic cell of mercury through which lithium is passed, while a

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cross-current draws off the lighter lithium-6. After the discovery of lithium-6 in Russian fallout, McLaren was brought to Oak Ridge and asked to design the American process. McLaren now complains that standards at the facility were sloppy. He says he could have easily designed a process to recover the mercury as well as the lithium, but that DOE, then AEC, was not interested. He has sued the government for negligently contaminating him with radiation, resulting in his terminal bone cancer.

According to a secret DOE study obtained by the Appalachian Observer under the Freedom of Information Act, 2.4 million pounds of mercury have been lost to the environment from Y-12 since 1955. 87-percent of the bluegill collected in the nearby Clinch River exceed the Food and Drug Administration action level for mercury—and some of them are 300 times the allowed edible limit. The unreported discharges of mercury in the 1950s exceeded state guidelines by nearly 3,000 times, and did so consistantly, month after month, year after year.

4.8 The S-3 Ponds and Bear Creek

At the other end of Y-12, discharge pipes drain some 1.5 million gallons of wastes (per year) into the headwaters of Bear Creek. The wastes include plating sludges and solutions, nitric and hydrochloric acids, stripping and cleaning solvents, uranium, beryllium, thorium, halogenated solvents, non-halogenated solvents and other substances. They flow into four diked ponds, known as the "S-3" holding ponds.

These ponds are unlined and leak badly. The wastes are completely untreated and eventually either leak into Bear Creek or evaporate off to the air. The nearest state water quality monitoring station is 5 miles downstream, but it only monitors for grease, oil, and acidity.

4.9 Oil Pond

Just North of Bear Creek Road as it crosses the County line is a pond, built in 1968, which catches the runoff from several old disposal trenches. For perhaps 20 years, these trenches were used for dumping oils and solvents laced with PCBs and other wastes. The trenches were still in use as recently as 1978, although leaking was observed to be occurring in the hillside in 1968, which is why the pond was built. A sample taken from the edge of the pond in 1983 showed 906.5 parts per million of PCBs. It continuously discharges into a Bear Creek tributary.

Until October, 1981, chemical wastes (including cyanide) were dumped into an "isolation area" just uphill from the oil pond and trenches. Disposal included both "evaporation pits" and "stand pipes" (shallow wells). The State has determined that groundwater on this hillside has been severely contaminated by perchlorethelyene and other chemicals.

There are also two active pits in the watershed above the oil pond and more pits are being dug in the same area. Contaminated solid waste is dumped

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into the pits, where it mixes with groundwater and surface runoff. The pits are used for the disposal of enriched uranium waste. There is no daily covering of the wastes. The freshly dug pits are slowly filling up with water. The groundwater is carrying the radioactive wastes deeper with every rainfall.

Down Bear Creek Road a little ways is the "Oil Land Farm", a plowed field where oils containing uranium and other heavy metals are deposited and plowed in. Surface runoff carries the black chemical waste through a marshy area and into Bear Creek.

These are just some of the discharge points from Y-12. Yet to be studied in detail are the discharge points from the spent fuel separation processes and isotope laboratories at X-10, or the hexafluorine discharges and uranium disposal pits at K-25, which may be equal or greater hazards to human health.

4.10 Deep-Rock Injection

Oak Ridge now disposes of its high and low level nuclear wastes by a method known as deep-rock hydrofracture. A 6-inch well casing is drilled to a depth of about 1000 feet in the Conasauga shale. The well is then cased and plugged at the bottom. A slit is sandblasted in the casing a few feet from the base and water is pumped into the well under pressures of 2500 psi. The pressure propagates horizontal crevices in the shale. A mixture of clay, fly ash, cement, high-level radwaste and sugar (to control the rate of solidification) is then pumped under pressure into the fracture. The resulting deposit is generally a thin, sweet pancake with a 150-meter radius.

After few months, another slot is opened in the casing, perhaps ten feet above the last, and the procedure is repeated. Each time some 80,000 gallons containing some 40,000 Ci (1,480,000,000,000,000 dps) of mostly strontium and cesium is deposited. By 1971, the amount of cesium in shale strata below Oak Ridge represented 7.5 thousand trillion disintegrations per second. The hazard of seepage of that radioactivity will remain for about 1,600 years, the time it will take that volume of cesium to decay to less than one dps.

Recent changes in Tennessee groundwater protection regulations ban the disposal of hazardous materials, including radioactive wastes, by deep-rock injection.[30] Hydrofracture is specifically prohibited, because the direction and extent of the fracture is an indeterminate risk. DOE has just completed a new waste injection facility, with an expected active life of 15 years. DOE plans to resume hydrofracturing at Oak Ridge in 1983, under the continuing presumption that a state may not regulate a federal reservation in general and nuclear power in specific. After the backlog of wastes that has been awaiting construction of the new well is eliminated, DOE plans to decommission its old underground storage tanks and inject the high-level radwaste sludges into the deep shale.

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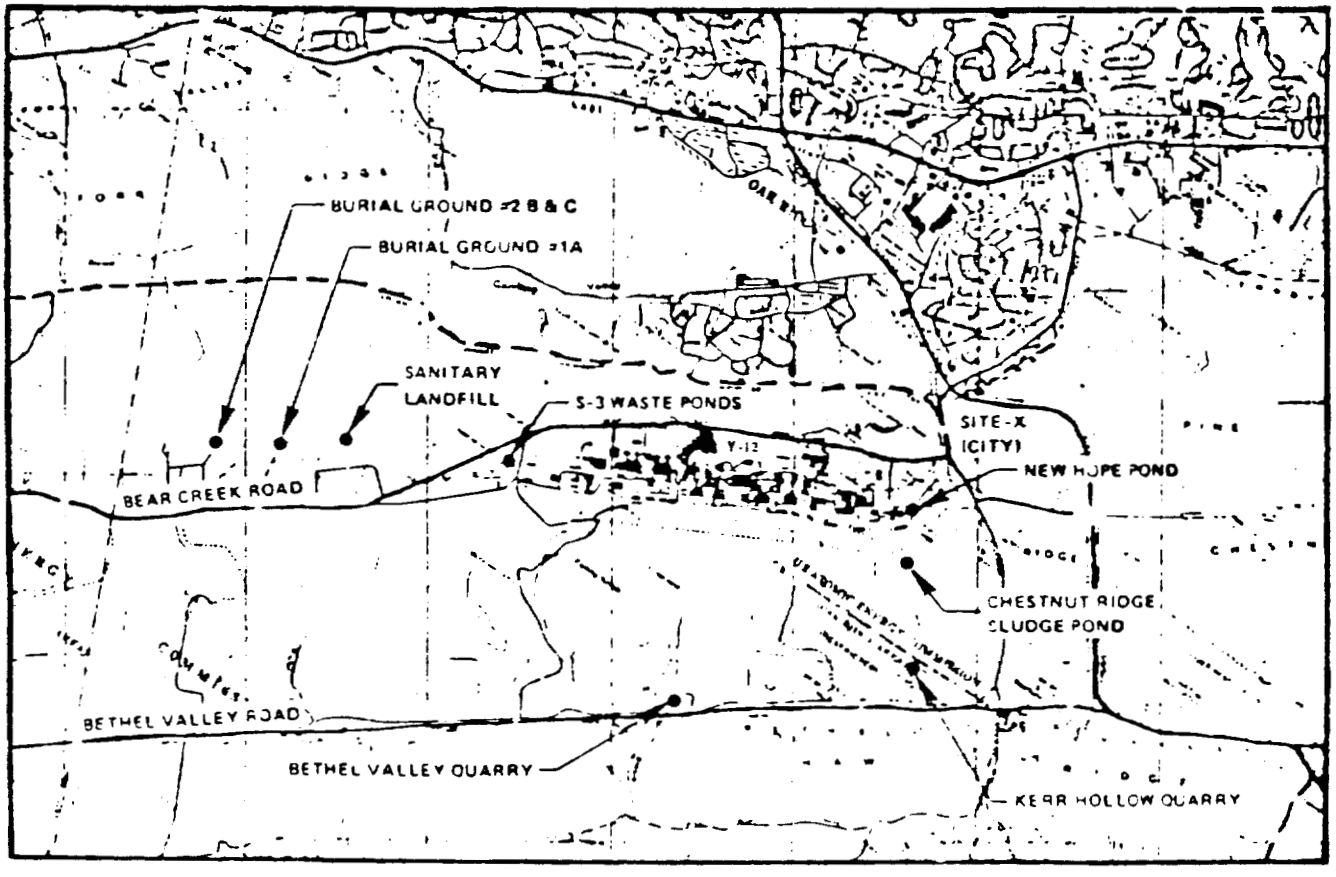
4.11 Radwaste Incineration

The Department of Energy is constructing a volume reduction system--radwaste incinerator--to burn its combustible low level wastes prior to deep rock injection. Previously, incineration had been ruled out because of concern for ambient air standards. However, recent operating experience at Los Alamos encouraged DOE to extend the idea to its other national laboratories in order to reduce their waste volumes and cut operating expenses.[31] Radwaste incineration can be directly proscribed by state law, under the existing provisions of the Clean Air Act.[32]



CHAPTER 5

THROWING MONEY AT SOLUTIONS

On March 8, 1983, the East Tennessee Regional Office of the Tennessee Department of Public Health issued a Notice of Non-Compliance to the Oak Ridge Operations Office for illegal discharges from the Y-12 plant. This was the first step in the process of enforcement.

On April 8, the Department of Energy met with the State and with the U.S. Environmental Protection Agency (EPA) in Atlanta to iron out differences of opinion concerning jurisdiction. On April 22, 1983, the EPA forwarded to the State and DOE a draft Memorandum of Understanding to clarify compliance objectives. After further negotiations on May 25 and 26, this Memorandum was signed by all parties. The Memorandum requires:

1. DOE will prepare a map of Y-12 discharges.

2. DOE will characterize the content of the discharges and describe the source processes.

3. DOE will submit an areawide monitoring plan and mitigation proposals.

4. DOE will apply to the State for permits by November 15, 1983.

5. DOE will close, isolate, and seal its waste dumps at New Hope Pond, New Hope Sludge Disposal Area, the S-3 ponds, the PCB pit pond, the Oil Land Farm, and all other disposal pits.

6. DOE will conduct a complete inventory of waste dump sites.

7. DOE will prepare a complete assessment of mercury contamination and a remedial plan.

8. DOE will study groundwater contamination for the Y-12 area, including the ridge disposal trenches.

The Memorandum also sets timetables for compliance, although the DOE has said it objects to any immediate action, because it is constrained by budget appropriations for the current fiscal year. DOE also refuses to close any of the ponds or disposal pits until a new treatment facility can be constructed.

While the Memorandum is a good starting point, the study and redesign process will take several years to complete. Moreover, it only addresses the situation at Y-12, and does not address the other discharge points from federal facilities at Oak Ridge. Undoubtedly these studies and the remedial actions will take a lot of money--billions of dollars in the final analysis. Objections may be raised to these expenditures, both within the defense nuclear community and within a budget-minded Congress. Still, with $1 billion dollars per day being spent for military defense in the later years of this decade, what's one or two days work after 40 years of neglect?

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CHAPTER 6

THE JURISDICTIONAL QUESTION

"The interrelationship of federal and state authority in the nuclear energy field has not been simple...."

-- Justice Byron White in Pacific Gas and Electric Company, et al. v. State Energy Resources Conservation and Development Commission, et al. (April 20, 1983).

Who protects the general public from pollution from Oak Ridge facilities? Two possibilities exist: the state and federal governments. Yet the Department of Energy claims exclusion from regulation by either, as successor to the Atomic Energy Commission. Cloaking itself in the secrecy of the Atomic Energy Act of 1954, DOE holds at bay the Nuclear Regulatory Commission, the Environmental Protection Agency, and all governmental divisions of the State of Tennessee.

Those members of Congress who participated in drafting the Atomic Energy Act were keenly aware that many unknown factors were involved in measuring the impact of atomic energy upon the national well-being. Indeed, the primary reason for establishing a federal monopoly under the 1946 Act had been to assure public health and safety while the unknowns were being explored.[33]

In deliberations on the 1954 Act, there were two steps discussed by Congress as being of possible assistance in providing protection of the public. First, a realistic set of regulations would be developed by a government body, within or independent of AEC. Second, the AEC would administer the regulations. Congress then proceeded to make the same agency which was responsible for development and promotion of nuclear energy its own regulator. This arrangement continued for twenty years, fully covering the formative years of development of radiation protection policies.

Only after the conflict of interest became apparent--with the cover-up of fallout health effects from weapons tests--did Congress finally separate the regulatory and developmental functions with the Energy Reorganization Act of 1974. After 1974, the Energy Resource and Development Agency (ERDA)--now DOE--took on nuclear production and promotion, and the Nuclear Regulatory Commission (NRC) took on regulation. However, DOE has maintained since the separation that while NRC may not have to pay alimony, neither does it get control of the Oak Ridge homestead. DOE claims that the "Commission," referred to as regulator of byproducts and wastes from its production facilities in the Act, now means DOE, not NRC, as successor to the AEC.

Section 274(c) of the 1954 Act, 42 U.S.C. § 2021(c)(4) states that "byproduct, source or special nuclear material" from federal activities "should, because of the hazards or potential hazards thereof, not be disposed of without a license from the Commission." For its part, NRC has not been aggressive in asserting jurisdiction. As numerous panels, commissions, and committees have concluded since the Three Mile Island accident, the mindset which characterized the regulatory posture of the AEC lingers still at NRC.[34] NRC is content not to have to deal with the difficult questions of nuclear

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mismanagement at national laboratories and defense plants.

It is our belief that NRC possesses the statutory authority to regulate the Oak Ridge facilities, although this authority could be made more clear.[35] The Act directs "the Commission" to "exercise its powers in such manner as to insure ... the production of health and the promotion of safety during research and production activities"[36] ... "to protect the health and minimize danger."[37]

The authority claimed by DOE for an exclusion from NRC licensing is far more tenuous. Section 110 of the Act, "Exclusions," removes from regulation only the Department of Defense, not the Department of Energy.

DOE claims it was exempted from licensing in 1974 by the Energy Reorganization Act. In that Act, Congress gave ERDA (now DOE) responsibility for insuring that its programs were environmentally sound and not adverse to public health and safety. [38] But notwithstanding the general exemption of ERDA programs from NRC licensing, Congress enacted section 202 of the 1974 Act to give NRC jurisdiction over ERDA reactors and waste management practices. Section 202 was not retroactive, but provided NRC authority to regulate any waste facilities built by ERDA or with ERDA appropriations after 1974 which would handle wastes for any period longer than ten years. The Senate Report reasoned:

> "At present, most of the wastes which are leaking from temporary tanks at AEC storage facilities are from the weapons programs. The committee intends that new facilities now being planned for long term storage of commercial wastes will meet the strict licensing standards of [NRC]." [39]

The wording of the 1974 Act may be construed to limit NRC jurisdiction over DOE to "high-level" nuclear wastes. "High-level" is generally defined as the second stage reprocessing wastes from spent fuel, or the equivalent level of radioactivity, a definition which places extremely toxic radioactive substances into the remaining categories of "low-level" or "transuranic" wastes. This may be the loophole through which DOE will seek to escape NRC licensure in the future.

EPA has jurisdiction over all solid and hazardous waste disposed at Oak Ridge under the authority of the Resource Conservation and Recovery Act. RCRA provides:

> "Each department, agency and instrumentality of the federal government... shall be subject to, and comply with, all federal, state, interstate and local requirements ... respecting control and abatement of solid waste or hazardous waste disposal in the same manner, and to the same extent, as any person is subject to such requirements."

Yet in January, 1982, Paul Cahill, the director of EPA's Office of Federal

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Activities ruled Oak Ridge exempt, apparently misreading the law. The EPA thereupon defaulted upon its obligations to enforce applicable federal standards upon the federal facilities at Oak Ridge.

The State has authority under the 1977 amendments to the Clean Air Act to regulate radioactive emissions to the air.[40] The State also has authority to regulate solid waste disposal of non-nuclear materials.[41] The question is whether the State can require the clean-up of hazardous dump sites that are leaking radioactive materials and poisoning the environment, and whether it can regulate nuclear discharges to protect its sources of public drinking water far into the future.

The most appropriate action for the State to take at this time is to seek NRC enforcement, and if necessary, an NRC rulemaking on the jurisdictional question.[42] If the NRC declines to assume jurisdiction, or to make the ruling, then under the April 20, 1983 decision in Pacific Gas and Electric, the State should move to enforce its own regulations. Pacific Gas and Electric specifically held that states may totally prohibit federally licensed nuclear facilities where no safe method of waste disposal has been demonstrated. The State is no longer pre-empted from active enforcement of existing state regulations. If the NRC assumes jurisdiction, that agency should take immediate steps to require remedial actions at Oak Ridge. If the NRC does not assume jurisdiction, or does not effect a clean-up, then the State should take jurisdiction upon itself and order compliance with state laws, and be prepared to order the closing of any of the Oak Ridge facilities that refuse to comply.[43]

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CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

DOE has argued that the amount of radionuclides migrating offsite to the Clinch River is less than 1 percent of the permissible limits after dilution and that concern is therefore groundless.[44] The State cannot obtain actual measurements of the discharge before dilution, which by itself constitutes non-compliance with existing laws. Under the present Memorandum of Understanding, DOE will voluntarily provide a characterization of the wastestream discharges to the State and take such remedial action as it deems necessary to bring its discharges within reasonable limits.

Under the Atomic Energy Act of 1954, as amended, the U.S. Nuclear Regulatory Commission has jurisdiction to regulate nuclear waste disposal from all federal facilities. NRC is obligated under the Act to assure that public health will not be endangered by nuclear activities.

Likewise, under the Resource Conservation and Recovery Act, the Environmental Protection Agency has jurisdiction to regulate all non-radioactive and some radioactive (solid hazardous wastes) discharges from Oak Ridge. EPA is similarly obligated to assure that the public health will not be endangered, but its obligation is much more far reaching, extending to non-human species of life and to generations far into the future.

While the State's Division of Solid Waste Management is eager to begin enforcement of standards for disposal of non-radioactive wastes at Oak Ridge, State radiological health authorities say they are ill-equipped to inspect and regulate the entire nuclear operation there. They would prefer to have the federal government shoulder its statutory responsibilities. It is therefore our recommendation that the State Attorney General petition the NRC to take jurisdiction over radioactive releases to the environment, and if no action is forthcoming, the Attorney General should ask the Commission for a formal rulemaking.

Should the NRC rulemaking be denied, or prove inadequate, the final agency determination should then be appealed to federal court. The Attorney General should proceed with enforcement of State laws and be prepared to appeal the jurisdictional question to the U.S. Supreme Court if necessary. In the meantime, the State Department of Public Health can continue in its effort to enforce the laws which remain well within its traditional jurisdiction. The Memorandum of Understanding provides a strict timetable which should be enforced by court action if necessary. Continuing violations should be halted at once. Cleanup operations should begin as soon as technically possible.

Atomic energy is inherently a dangerous activity, one which generates many long-lived poisons that must be carefully kept from the environment. White Oak Lake and East Fork Poplar Creek are perfect examples of what can happen in the absence of reliable governmental regulation. Oak Ridge still has radioactive releases to the environment of significant magnitude--well beyond the limits allowed by current state and federal regulations, even after dilution is factored.

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It doesn't seem too much to ask that there be one set of standards for all nuclear industries. Union Carbide, Montsano or DuPont shouldn't have a weaker standard because they are regulated by DOE than does TVA has because it is regulated by NRC. What condition would the state be in if TVA or Nuclear Fuel Services of Erwin suddenly said that they were exempt from all state and federal regulations at all of their facilities?

DOE is the production manager at Oak Ridge and is responsible for meeting production quotas. As such, it is unlikely to be interested in strict enforcement that could result in production delays. It is not a suitable regulator for its own facilities.

The U.S. Congress should take steps to clarify this jurisdictional impasse, and to make one set of safety standards for all. Until that time, the State should enforce its laws, and be prepared to defend that enforcement in court.

Respectfully submitted,

Albert Bates

Albert Bates
Director

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APPENDIX A

NOTES AND REFERENCES

[1] Senate Bill 1082 (Albright); House Bill 1132 (McNally).

[2] Senate Bill 468 (Moore and Burlison); Senate Bill 892 (Crockett and Davis); House Bills 945 and 955 (Yelton, Brewer and Kernell).

[3] Senate Bill 892; House Bill 955.

[4] Senate Bill 627 (E. Davis); Senate Bills 468 and 892; House Bills 945 and 955.

[5] Senate Bill 1083 (Albright); House Bill 1127 (U.A. Moore).

[6] Senate Bill 1082; House Bill 1132.

[7] Pacific Gas and and Electric, et al. v. State Energy Resources Conservation and Development Commission, et al., No. 81-1945, 51 Law Week 4449 (April 20, 1983). The majority opinion speculated that state regulation could be unconstitutional if its aim was to regulate nuclear safety. A separate opinion by Blackmun and Stevens said safety concerns were also an acceptable rationale for state regulation. Despite this difference of opinion, the Court was in unanimous agreement that states may regulate federally licensed nuclear facilities for economic reasons. In the case of Oak Ridge, the prospects of more expensive water treatment programs downstream and more expensive medical care for Tennesseans who ingest poisoned crops and wildlife are valid economic concerns.

[8] Gofman, J.W., Radiation and Human Health (Sierra Club Books, San Francisco, 1981); Morgan K.Z., "Hazards of low-level radiation," Encyclopedia Britannica, 1980 (Encyclopedia Britannica, Chicago, 1980), at 214-229.

[9] National Research Council, Advisory Committee on the Biological Effects of Ionizing Radiations, The Effect on Populations of Exposure to Low Levels of Ionizing Radiation: 1980 (Academy Press, Washington D.C.: 1980); See too: Mancuso, et al., "Radiation Exposures of Hanford Workers Dying from Various Causes," Health Physics 37:617 (Nov. 1979).

[10] The letters and numbers on the buildings were assigned chronologically rather than by building function, in the order of construction.

[11] United States vs. 52,600 acres of land in Roane and Anderson Counties, Tennessee and Ed. C. Browder, et al., Civil Action No. 429, District Court of the United States for the Eastern District of Tennessee, Northern Division (October 6, 1942).

[12] Brown, A.C. and C.B. MacDonald, The Secret History of the Atomic Bomb (Dell Publishing Co., New York, 1977).

[13] 46 Federal Register 15167. These figures exclude the significantly

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greater effects of radon-222 released in mining and milling, and technicium-99, not yet calculated. They also assume, contrary to past experience, that mill-tailings liquor, transuranic wastes, and high-level fission products will be kept in perfect isolation from the environment in perpetuity, resulting in zero population dose from those products. Finally, the estimates used by the NRC to calculate radiation health effects employ antiquated figures to estimate transport, uptake, and biological effects, and if corrected with current estimates, would yield an end-product perhaps three to five orders of magnitude greater (1,000 to 100,000 times the number of officially-estimated deaths). See: Bates A. and M. McClure, eds., Shutdown! Nuclear Power on Trial 2d.Ed. (Book Publishing Co., Summertown TN, 1979).

[14] Morland, H., The Secret That Exploded (Random House, New York, 1981).

[15] Morgan, K.Z., "Health Physics and the Environment" (1972), in Effect of Radiation on Human Health, Hearings before the Subcommittee on Health and the Environment of the Committee on Interstate and Foreign Commerce, Ser. No. 95-179 (Vol. 1; 1978), at 77.

[16] Cowser, et al., "Preliminary Safety Analysis of Radionuclide Release to the Clinch River" in Transport of Radionuclides in Fresh Water Systems (Univ. of Texas, 1963); AEC/TID-7664, at 17-38.

[17] Willard, W.K., "Avian Uptake of Fission Products From an Area Contaminated by Low-Level Atomic Wastes," Science 132:148 (July 15, 1960). A milliRoentgen (mR) is a unit for measuring ionization in dry air. For the most common forms of radiation, it is approximately equal to a millirad (mrad), the unit for measuring absorbed dose in tissue, although some radiation will not be absorbed. A millirem (mrem) is a measure of biological effectiveness, taking account of the fact that alpha particles are some 30 times more damaging to organic molecules than are gamma rays. For gamma radiation, mRs or mrads are approximately equal to mrem. EPA currently permits 25 mrem/year to members of the general public from all nuclear processes, although the actual average exposure is well below this (but see Note 13). Background radiation from soil in the United States ranges from 0.001 to 0.034 mR/hr but is normally around 0.0085 mR/hr.

[18] Willard, ibid. Strontium-90 levels were measured at 1487 pCi/g and Cesium-137 levels were as high as 18,600 pCi/g (688 cps/g). In human bone, the maximum EPA-permissible concentrations for these elements are from 25 to 250 pCi/g.

[19] C.T. Carten and R.C. Dahlman, "Plutonium in Biota from an East Tennessee Floodplain Forest, Health Physics 34:705-712 (1978).

[20] Gofman, J.W. and A.R. Tamplin, Poisoned Power (Rodale Press, Emmaus PA, 1979). It is estimated that one ounce of plutonium contains from 100 billion to 10 trillion fatal human lung doses.

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[21] Morgan, op cit, note 13.

[22] Auerbach, S.I., "Ecological Considerations in Siting Nuclear Power Plants: The Long-Term Biotic Effects Problem," in Ecological Aspects of the Nuclear Age: Selected Readings in Radiation Ecology, AEC/TID-25978 (1972); and Auerbach interview in Wyrick, B., "The Troubles at Oak Ridge," Newsday (1978).

[23] Morgan, op cit., note 13; Wyrick, ibid., note 22.

[24] Wyrick, op. cit., note 22.

[25] Id.

[26] Moreland, op cit., note 14, at 76-77.

[27] 10 CFR 20, Appendix B, Table II sets the maximum permissible limit at 0.003 microcuries per milliliter or 3,000,000 pCi/l. State regulations are identical.

[28] Looking at the grab-bag sample more closely, 23,241 pCi equals 859 dps (at 3.7 x 10E10 dps/Ci) which equals 4,896,300 electron volts (at 5,700 eV/disintegration) which equals 7.8 x 10E-6 ergs (at 1.60206 x 10E-12 ergs/eV) spread over some 70,000 grams of tissue. A rad is, by definition, 100 ergs per gram of tissue. If a person were to drink a liter from the grab-bag, their whole body dose would be less than one thousandth of a millirem.

[29] State Department of Public Health, Notice of Noncompliance (March 8, 1983); and see: Appalachian Observer, 2:34:1, Clinton, Tennessee (April 6, 1983)

[30] Rules of the Water Quality Control Board, Chapter 1200-4-6-.13, Proposed April 11, 1983.

[31] Borduin, L.C., and A.L. Taboas, "DOE Radioactive Waste Incineration Technology," Nuclear Safety 22:1;56 (Jan-Feb, 1981).

[32] Stensvaag, J-M, "State Regulation of Nuclear Generating Plants Under the Clean Air Act Amendments of 1977," 55 So.Cal.L.R. 511 (March 1982).

[33] Joint Committee on Atomic Energy, "Atomic Energy Act of 1954," Senate Rep. No. 1699, 83rd Cong. 2d Sess., U.S. Code Cong. and Admin. News 1954, at 3458.

[34] Report of the President's Commission on the Accident at Three Mile Island, The Need For Change (Oct. 1979); The NRC (Rogovin) Report on the Accident at Three Mile Island (1979); U.S. General Accounting Office, "Evaluation of NRC Performance in its First Five Years" (Jan, 1980); Senate Committee on Environment and Public Works, "Nuclear Accident and Recovery at Three

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Mile Island" (1980); Advisory Committee on Reactor Safeguards, "A Review of NRC Regulatory Processes and Functions" (1980).

[35] See, e.g.: 42 U.S.C. §§2011, 2012, 2013, 2051, and 2201.

[36] 42 U.S.C. §2051 (a)(5).

[37] 42 U.S.C. §2201 (i)(3); and see: 42 U.S.C. §§2012(d), 2012(e), 2013(d).

[38] See S. Rep. No. 93-980, 93rd Cong., 05/27/83. Sess. 1-2, at 2, 24, 30, reprinted in [1974] U.S. Code Cong. and Admin. News 5470, 5492; and see also 42 U.S.C. § 5812(d) (1976) establishing office of environmental safety within ERDA.

[39] Id. at 59-60; and see: H.R. Rep. No. 93-1445, 93rd Cong., 2d. Sess. 33-34 (conference Report), reprinted in [1974] U.S. Code Cong. and Admin. News 5470; and Natural Resources Defense Council v. Nuclear Regulatory Commission, 606 F.2d. 1261, 1267 (1979).

[40] See note 32.

[41] See correspondence between Dept. of Public Health and DOE, appended.

[42] See 10 CFR 2.206, 2.208.

[43] But see: Northern States Power Co. v. Minnesota 447 F.2d. 1143 (8 Cir. 1977), aff'd, 405 U.S. 1035 (1972). Section 274(k) of the 1954 Act, 42 U.S.C. § 2021(k) states: "Nothing in this section shall be construed to affect the authority of any state or local agency to regulate activities for purposes other than protection against radiation hazards." Under this section, state programs are permitted only if they are "coordinated and compatible" with those of the NRC. Where the NRC has not pre-empted the field, the state has a free hand to regulate. Cf. NRC Authorization Act for Fiscal 1980, Pub. L.. 96-295 § 108(f), 94 Stat. 783 (1980).

[44] Wyrick, op. cit., note 22.